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AGRICULTURAL NEWS LETTER

VOL. 8 - NO. 6 NOVEMBER-DECEMBER, 1940

This publication contains information regarding new developments of interest to agriculture based on laboratory and field investigations of the du Pont Company and its subsidiary companies. It also contains published reports and direct contributions of investigators of agricultural experiment stations and other institutions as related to the Company's products and other subjects of agricultural interest.

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Vol. 8 - No.6. Nov. - Dec., 1940.

AGRICULTURAL NEWS LETTER

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PHENOTHIAZINE, THE NEW ANTHELMINTIC

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EDITOR'S NOTE: During the past few months, a rapidly growing interest has been developed on the part of livestock and poultry raisers in Phenothiazine, which is showing remarkable value for the removal of internal parasites from animals. The leading article in the November 16-30, 1940, issue of "The Farmers Guide" of Huntington, Ind., discussing this chemical, says: "Phenothiazine, in various combinations and under various conditions, is going through a series of critical tests in the laboratories and experimental orchards of the United States Department of Agriculture. If it meets the expectations of department scientists, Phenothiazine will eventually become one of the farmer's most important chemical aids. The following is meant to be a preliminary statement. The table summarizes information available in the literature on the use of the chemical with various animals, the procedures being subject to modification as further experience is gained. Present plans call for subsequent articles in the "Agricultural News Letter", giving results of experimental work with Phenothiazine as these results are made available.

Phenothiazine is a synthetic organic chemical. For the past several years it has been undergoing thorough tests by the du Pont Company and U. S. Department of Agriculture entomologists as an insecticide, primarily for codling moth control. More recently, investigators in the Bureau of Animal Industry of the U. S. Department of Agriculture, discovered the unusual anthelmintic value of the product for animal treatment and the drug is already finding commercial distribution by the du Pont Company thru veterinary supply and stock remedy concerns.

Phenothiazine possesses many advantages over previously used anthelmintics. For example, it is an odorless, tasteless, finely divided powder which is nontoxic in therapeutic doses. With many animals it has been found free from toxic action even in quantities up to several times that required for effective anthelmintic action. Phenothiazine, in contrast to most anthelmintics, will remove more than one kind of worm from a given type of animal and in many cases it is the only treatment known for removing certain particularly important internal parasites.

Since Phenothiazine is a rather recent development, much research work on the optimum dosage, method of administration and other details is still in progress.

Animal	Dosage	Method of Administration	Advantages	Remarks
Sheep & Goats	25-g. - adults 15-g. - lambs	Gelatine capsules Compressed bolus Drench	Removes all of the more important internal parasites such as stomach worms and nodular worms. Only treatment known for nodular worms.	Present dosage is somewhat bulky to administer. Urine of treated animals becomes red on exposure to air necessitating precautions to prevent staining wool.
Horses & Mules	50-g. for animals weighing about 1,000 pounds	Gelatine capsules Compressed bolus Drench Mixture with feed	Unusually effective for removing both large and small strongyles.	Not effective against bots.
Cattle	50 - 80 grams for adult animals	Same as for sheep	Removes stomach worms and nodular worms with high efficiency.	
Poultry	0.05 - 0.5 g. for chickens and up to 1.0 g. for large turkeys.	Tablets Drench Mixture with feed	Highly effective for removing cecal worms. This parasite is a vector for the organism causing blackhead disease and consequently the Phenothiazine treatment may eventually prove of some value in controlling blackhead.	Probably not effective against other poultry parasites such as roundworms. Mixtures of Phenothiazine with other poultry anthelmintics may offer means for single treatment control of several parasite species.
Swine	25# animal - 5 g. 25-50# " - 8 g. 50-100# " -12 g. 100-200# " -20 g. Over 200#" - 30 g.	Capsule Bolus Drench Mixture with feed	Only effective treatment known for nodular worms in swine.	Not highly effective against roundworms, at least in the dosage suggested.

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A NEW SOURCE OF VITAMIN "D" FOR POULTRY

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EDITOR'S NOTE: Six years ago there was published in the "Journal of Biological Chemistry" an article entitled the "Pro-vitamin D of Cholesterol" under the authorship of Dr. J. Waddell. The conclusion of this Du Pont Scientist marked the starting point of the development that today has become of significant importance in the world of nutrition.

It has long been known that the nutritional element, vitamin D, occurs naturally as a result of the activation by the ultra-violet rays of the sun of a sterol present in skin tissues. Nature apparently intended that other vitamins be supplied in foods, while vitamin D effect should be supplied partly by the calcium and phosphorus in foods, and partly by the ultra-violet rays of the sun.

As early as 1924, the benefits of the vitamin D of certain fish liver oils were recognized and this source of vitamin D began to be used as a nutritional constituent in poultry mashes. Subsequently, it was expected that irradiated ergosterol made possible through the work of Dr. H. Steenbock of the University of Wisconsin, would make available to poultry nutritionists another source of vitamin D. However, irradiated ergosterol proved to be something on the order of 1/50 as effective, unit for unit, as the vitamin D of certain fish liver oils.

Continued investigations, following the Waddell disclosure, led to the discovery of a third source of vitamin D which might be termed a combination of Nature's way of supplying the vitamin and the way the vitamin is supplied by cod liver oil. In Nature's way, a sterol in the body is activated by ultra-violet rays. Cod liver oil contains an activated sterol of similar biological activity. The principal distinguishing difference between these two sources, is the method by which the animal or human receives the source of vitamin D. To produce this third source of vitamin D, the scientist first extracts the sterol from an animal source. The molecular construction of this sterol is changed by subjecting the sterol to ultra-violet light, and at this point the activated sterol produced by man is undoubtedly similar to the sterol in the body that has been activated by the ultra-violet rays of the sun. This activated sterol is fat soluble, and as there is no need for a crystalline substance, it is offered in an edible vegetable oil base with a potency approximately two thousand times greater than the potency of ordinary cod liver oil.

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Of utmost importance, in the production of any source of vitamin D for poultry is the chick assay. The Association of Official Agricultural Chemists has specified a method to determine the potency of any source of vitamin D to be used for poultry (potency expressed in A.O.A.C. chick units). In the Du Pont biological laboratory this specified method is amplified in order to reduce the assay error. The data from a typical Du Pont assay to determine the A.O.A.C. chick potency of "Delsterol" activated animal pro-vitamin follow:

VITAMIN D ASSAY BY PREVENTIVE BIOLOGICAL TEST*

DELSTEROL-Production No. 9-44

Supplements to Basal Diet	Series Number	AOAC Units per 100 Grams	Number of Chicks	Weights of Chicks Averages of Groups Start	Weights of Chicks Averages of Groups End	Ash of Extd. & Dried Bones
				GRAMS	GRAMS	PER CENT
Corn Oil Only			19	37.0	141.5	32.1
Reference Cod Liver Oil	I	6	20	36.5	162.4	35.3
	II	6	21	36.7	157.3	36.2
	I	12	19	37.1	165.8	40.2
	II	12	19	36.7	176.1	39.5
	I	16	15	35.7	167.0	43.0
	II	16	19	36.9	183.9	42.8
"Delsterol" 9-44	I	6	20	36.3	168.1	35.9
	II	6	20	37.6	161.5	36.2
	I	12	20	36.2	174.4	41.3
	II	12	20	36.9	186.3	40.6
	I	16	19	37.0	180.7	43.3
	II	16	21	36.9	170.8	42.4

*TENTATIVE METHOD--Jour. Ass'n. Off. Agr. Chem. 22, 81, 1939

This new source of vitamin D was submitted as a new drug to the Food and Drug Administration immediately upon the passing of the Federal Food, Drug and Cosmetic Act. The Food and Drug Administration found no cause to reject the application. It is interesting to note in the application to the Food and Drug Administration, extensive toxicity studies were submitted.

This new source of vitamin D, marketed under the trade-mark "Delsterol," fills a long-felt want in the poultry nutrition field. Certain fish liver oils and fish oils were standard sources of vitamin D for poultry. As knowledge of the

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vitamin D requirements of poultry increased, it was discovered that larger and larger amounts of vitamin D were necessary for optimum egg production, growth and hatchability of eggs. The increase in the amount of oil presented a problem which was solved in part by the addition of concentrated oils or naturally highly potent oils that were available. In more recent years poultry feed mixers obtained fortified oils with four or five times as many units of vitamin D as had been possible to obtain ten years ago. A ton of good laying mash ten years ago, contained twenty pounds of straight cod liver oil, but with fortified oils available only five pounds per ton is now necessary.

The source of vitamin D concentrates from fish liver oils and the source of highly potent fish liver oils has not always been certain however. Fish liver oil concentrates were expensive, and highly potent natural oils were uncertain at the best, and when efforts of the biological chemists and organic chemists combined to produce a reliable standardized source of vitamin D as effective unit for unit as cod liver oil, the poultry nutrition world tested such material in the laboratory and in the field and accepted it.

This new source of vitamin D has still another asset. It can be readily dispersed in a powder carrier. This provides the feed mixer a source of vitamin D that can be just as readily dispersed in a ton of mash but which weighs only one-fifth as much as the specially fortified fish liver oils. The powder carrier also eliminates the possibility of imparting a taste or odor to the poultry meat, an ever present problem confronting the turkey producer.

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"MYCOBAN" MOLD INHIBITOR OFFERS SOLUTION OF OLD PROBLEMS OF HOUSEWIFE, FOOD MANUFACTURER AND FARMER.

By-

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Mold growth on various food products is not uncommon in the household, whether it be in metropolis or farm. Blue, green, brown or black felt-like growths may occur on the partly consumed glass of jelly, on smoked meats, on cheese or bakery products such as bread and cake. Readers of the "Agricultural News Letter" will undoubtedly remember an article entitled "How Fungi Destroy or Serve in Various Ways According to Forms and Numerous Conditions" by W. H. Tisdale which appeared in the March 1939 issue. As was mentioned there, not all the molds cause damage--in fact some of them are of great use to man. Thus even in cheese the growth of some types of Penicillium mold is necessary to produce the characteristic flavors of such cheeses as Roquefort, Stilton and Gorgonzola.

So far as is generally known, no mold which commonly occurs on food products is the cause of food poisoning. Nevertheless these molds do change the flavor of most foods on which they grow and all of them cause an undesirable appearance. In spite of their supposed non-toxicity, one would think twice before eating a jelly which is contaminated with innumerable blue or green mold spores.

Estimates of the dollar losses caused by mold growth are various, but even the more conservative estimates of food losses run into many millions of dollars annually.

It has been known for a long while that acetic acid--the main active component of vinegar--will retard mold growth. Perhaps our ancestors first used vinegar not as a condiment, but as a means of retarding the growth of mold or other microorganisms. Chemically speaking, the next acid in the series above acetic is propionic, and the next acid above propionic is butyric. These three acids are produced in nature by the growth of various bacteria, in fact most of our cider vinegar is manufactured by means of bacteria. The type of bacterium which produces propionic acid in greatest amount has been given the name of "propionibacterium". This organism was first isolated from Swiss cheese and it is now well recognized that its presence is necessary in the manufacture of that cheese if the characteristic flavor is to be developed.

Recent chemical studies have shown that these bacteria produce as much as 0.6% of propionic acid in Swiss cheese of the most desirable type. It occurs also

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in other food products such as cider vinegar, sour milk, butter, wine, and other cheeses, though in much smaller amounts than in Swiss cheese. Thus propionic acid occurs naturally in many items of the average diet.

Propionic acid was found to be approximately four times as effective a mold inhibitor as acetic acid. This discovery was of commercial significance but propionic acid from bacterial fermentation was too costly because the process is slow and the yields small. Chemical research has made available unlimited quantities of propionic acid at low cost so that over a million pounds now are being used annually in foodstuffs.

"Mycoban"*, the Du Pont trade name for propionic acid and its salts, found immediate acceptance in the baking industry. The addition of small quantities of the salts, sodium or calcium propionate, (2-1/2 to 5 oz. per 100 lbs. of flour) will extend the mold-free life of bread up to 7-8 days beyond the normal mold-free time, depending upon type of bread and conditions under which the bread is used. The "Mycoban" is added to the dough ingredients before the final fermentation. The yeasts necessary for leavening of the bread are unaffected by "Mycoban", but the "Mycoban" which remains in the loaf after baking, is sufficient to retard the growth of mold during the time necessary for its consumption in the home. Thus we see that the propionates are selective in the organisms on which they act. In bread baking the propionates essentially have no effect upon the yeasts but do have an effect on the mold spores which settle on the bread as it comes from the oven, goes through the slicing machine or during opening of the bread in the home.

IN DAIRY INDUSTRY

In the dairy industry we again see the selective effect of propionic acid and its salts on microorganisms. Bacteria known as Streptococci and Lactobacilli are necessary for curd formation of most types of cheese. Propionates added to milk for the manufacture of cheese do not affect the growth of the useful bacteria but retard the development of most molds and some undesirable yeasts which frequently occur on various cheese products. Parchment paper and other types of wrapping materials for food products can be treated with "Mycoban" solutions. The use of such "Mycoban" treated parchment will retard surface growth of mold on various dairy products such as cheese and butter. In the same manner a parchment liner for a jelly glass will also delay the development of these objectionable blue and green molds which the housewife knows so well.

*Trade-mark registered U. S. Patent Office

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NEW WOOD TREATMENT SIMPLIFIES BENDING

EDITOR'S NOTE:- The following is quoted from an article by J. L. Stearns, which appeared in "Southern Lumberman", Vol. 161, No. 2030, November 1, 1940. Mr. Stearns pcints out that during experiments with the chemical treatment of wood with urea,* it was accidently found that wood heavily treated with urea would bend very easily when heated. His article is illustrated with a U. S. Forest Products Laboratory picture of several specimens of wood bent after urea treatment, a disc made from urea-treated sawdust, and a disc which shows how urea-treated oak can be welded under the influence of elevated temperature and pressures.

"Originally urea was used in making tests for more rapid seasoning of wood. Among the first substances tried, common salt proved quite successful, but it was also found that lumber treated with salt corroded most metal hardware, nails, etc., that were used in this lumber after construction. Therefore, salt was abandoned and a search was made for something to supplant it which would not attract moisture. Urea was the outcome of this investigation. It was found that lumber treated with urea was fire retardant.

"W. K. Loughborough, of the U. S. Forest Products Laboratory, is credited with the development of this process. It was during tests for fire resistance that Mr. Loughborough accidently discovered that the test samples when heated to about 175°F. would bend very easily. In fact, they could be twisted, bent and distorted with amazing ease. After cooling, the pieces seemed to retain their new shapes without any apparent fractures, broken fibers or other injury. This discovery opened a new field of opportunity for urea. Boat ribs, wagon rims, furniture and countless products in which bent wood members are required will soon provide a ready market for lumber thus treated.

*See Agricultural News Letter, Vol.8, No.2, March-April, 1940. It should be pointed out that chemical seasoning to prevent splitting and checking during drying is a surface treatment wherein an amount of about 40 pounds of urea per thousand board feet is generally used. In treating wood for bending, as described in this article, the wood is completely impregnated with urea, the treated wood containing more than 500 pounds of urea per thousand board feet.

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"In this new treating process any wood may be used. The green lumber is immersed in a saturated solution consisting of one pound of urea to one pint of water and allowed to soak at room temperature for a period of one week per inch of thickness of the lumber..... The treatment is comparatively inexpensive. After treatment the lumber may be stacked up for ten years, if necessary, and bent any time, anywhere, by merely heating to a temperature of 175°F. This will mean that a firm not equipped with steaming and bending facilities can use this treated material without installing new equipment. A steam coil radiator with a box over it, or anything capable of heating the wood to 175°F., is about all that is necessary.

"The principle of this treatment lies in the chemical reaction of urea with lignin, one of the substances of which wood is composed. When the two combine a thermo-plastic results which, as the name indicates, is plastic only when heated. Urea-treated lumber is more resistant to decay than untreated stock and in drying it definitely reduces the tendency to check.

"With all these advantages before it urea will doubtless find many friends in the lumber industry."

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SOUND MOTION PICTURES ON SEED TREATMENT

Editor's Note:- The Bayer-Semesan Company of Wilmington, Delaware offers the following series of sound-on-film motion pictures. These films are available both in the standard 35 mm. and 16 mm. sizes. They emphasize the importance of research and have been produced with the cooperation of leading Federal and State agricultural authorities.

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"BLACK SCOURGE" illustrates modern methods of seed treatment for reducing grain disease losses. This film shows in detail the life story of stinking smut of wheat together with some of the most dangerous disease enemies of grain such as the smuts of oats and rye, stripe disease of barley, and seedling diseases of corn.

"SEEDS OF PROSPERITY" dramatizes the fight that science is making for the benefit of farmers, industry and the whole nation -- the fight against the boll weevil, and diseases such as Anthracnose, angular leaf spot, sore-shin, and boll rot. One sequence shows a number of the many products made from cotton.

"FEEDING THE MULTITUDE" portrays scenes of the distribution of vegetables in the wholesale and retail markets in New York City. This film also tells the story of diseases the vegetable growers must overcome to deliver high quality produce at the market.

"PERUVIAN GOLD" pictures the early history of the potato in Peru, and presents important information about the American potato crop and the vast amount of money lost from diseases. The symptoms of the several important seed-borne diseases and methods of combating them are given. The Rhizoctonia fungus is seen actually growing from its sclerotia.

"GRAIN THIEVES" illustrates the various steps in marketing grain including inspection, dockage, and dumping a box carload of wheat. It shows the farmers' tremendous losses from cereal diseases and a method of reducing these losses.

"TALL CORN" portrays the causes of missing hills, weak, barren stalks and "down" corn. The actual growth of a root-rot organism responsible for rotting of the seed, roots, and stems of the corn, is presented. The improvement in crop quality and yield through fighting disease is seen in actual field results.

"KING COTTON" narrates the story of how an unsuccessful cotton grower learns to raise paying crops of cotton by utilizing diseased control and other proved crop practices. Stop-motion photography shows plants growing from unprotected and protected seed and the killing of a plant by damping-off.

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THE AVAILABILITY OF THE INSOLUBLE NITROGEN DERIVED FROM UREA-AMMONIA LIQUOR-37 AND OTHER SOURCES

EDITOR'S NOTE: Many farmers favor inclusion of a small quantity of water-insoluble nitrogen in their fertilizers. However, since supplies of most of the materials carrying such nitrogen have become scarce and prices high, du Pont chemists were assigned to develop a process by which low-cost insoluble nitrogen might be synthesized. The project necessarily included studies of the agronomic value of the synthetic insoluble nitrogen. This portion of the work was conducted by Dr. M. M. McCool, Boyce Thompson Institute of Plant Research. As a result of these chemical and agronomic studies, the Ammonia Department has recently introduced a new fertilizer material, Urea-Ammonia Liquor-37 (UAL-37) which furnishes a limited amount of synthetic, water-insoluble nitrogen. The following article is based on a paper "Comparison of Agronomic Value of the Insoluble Nitrogen Derived from Urea-Ammonia Liquor-37 and Other Sources", by Dr. McCool, which will appear in Volume 11, Number 6 of "Contributions from Boyce Thompson Institute", Jan. - Mar., 1941. Reprints of his paper will be sent upon request.

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Urea-Ammonia Liquor-37 was developed to meet a demand for low-cost, water-insoluble nitrogen. UAL-37, in addition to furnishing a source of urea and inorganic nitrogen, is characterized by the fact that one-fifth of its nitrogen becomes water-insoluble during the fertilizer manufacturing process. The nitrogen content of UAL-37 is distributed as follows:

Inorganic, as free ammonia	20.5% N
Water-soluble organic, as urea	9.1% N
Insoluble organic compounds	7.4% N
Total	37.1% N

The indicated composition does not exist in solution since the insoluble nitrogen compounds are formed after the fertilizer has been ammoniated.

Dr. McCool's studies* were made to determine the availability and agronomic value of the synthetic insoluble nitrogen derived from UAL-37.

*See Editor's Note above.

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The experiments included a comparison with standard sources of water-insoluble nitrogen and the influence of various fertilizer storage conditions on the availability of the insoluble nitrogen. Nitrogen availability was measured by means of vegetative and nitrification experiments.

The samples of synthetic insoluble nitrogen used in the experiments were prepared by ammoniating superphosphate with UAL-37 and subsequently washing with distilled water to remove all soluble nitrogen. All the organic materials were washed to remove the soluble nitrogen.

Results of Experiments with Different Sources of Insoluble Nitrogen

The results of the vegetative experiments with several common sources of insoluble nitrogen are presented in Table 1.

Table 1

Availability of Different Sources of Water Insoluble Nitrogen As Indicated by Crop Growth and Nitrogen Removal

Source of Insoluble Nitrogen	Norfolk Fine Sandy Loam		Gloucester Loam			
	Millet		Corn		Tomatoes	
	Dry Wt. grams	N in Crop mgms.	Dry Wt. grams	N in Crop mgms	Dry Wt. grams	N in Crop mgms.
Control (No N)	4.8	48	4.8	42	5.5	63
Cottonseed meal	17.8	223	20.5	266	16.0	253
UAL-37 base	12.7	159	21.0	248	15.5	262
Process tankage*	10.3	111	13.2	132	8.0	141
Garbage tankage	3.1	42				

*Composite of seven commercial samples.

On the Norfolk fine sandy loam, the largest yield and the highest nitrogen removal by the crop were secured with cottonseed meal. The insoluble nitrogen from the UAL-37 base produced better growth than process tankage. The latter produced more than a 100 per cent increase in growth and nitrogen removal. Crop growth was slightly reduced by garbage tankage.

The yield of corn and tomatoes on the Gloucester loam was substantially the same with cottonseed meal and synthetic insoluble nitrogen. Both of these materials produced large increases in crop growth and were quite superior to process tankage. The nitrogen recovery data indicate the same differences as the yield data. The cultures of Gloucester loam were re-planted to millet to determine the residual effect of the different sources of insoluble nitrogen. The average dry weight of the millet following corn and tomatoes was 0.64 grams on the controls, 2.27 grams with cottonseed meal, 4.72 grams with insoluble nitrogen from UAL-37, and 1.58 grams with process tankage. These data indicate the residual effect of the insoluble nitrogen from UAL-37 is somewhat greater than from cottonseed meal.

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The same sources of insoluble nitrogen were compared in nitrification experiments. The soil used was a mixture of equal parts of Norfolk fine sandy loam and Gloucester loam. Incubation was at 27°C. The results secured are given in Table 2.

Table 2

Availability of Different Sources of Water Insoluble Nitrogen as Indicated by Nitrate Formation

Source of Insoluble Nitrogen	Nitrate nitrogen, parts per million of soil		
	30 days	60 days	90 days
Control (No N)	10.6	14.6	14.7
Cottonseed meal	49.3	60.5	61.6
UAL-37 base	43.7	64.5	79.5
Process tankage	31.4	34.3	36.8
Garbage tankage	5.1	14.7	12.1

Cottonseed meal and the synthetic insoluble nitrogen produced similar quantities of nitrate nitrogen after 30 and 60 days incubation. The synthetic material produced higher levels of nitrate nitrogen at the end of 90 days. Process tankage produced about one-half as much nitrate nitrogen as cottonseed meal and the synthetic material. Garbage tankage caused a slight reduction in the nitrate nitrogen, particularly at the 30-day period. These nitrification data are in close agreement with the results of the vegetative experiments.

Influence of Storage Conditions on Availability

Following ammoniation, fertilizers are stored under quite a range of conditions. Experiments were, therefore, made to determine the influence of the time and temperature of storage on the availability of insoluble nitrogen from UAL-37. UAL-37--superphosphate bases were made and stored under the conditions indicated in Table 3. After storage, they were washed to remove all soluble nitrogen and the residues used in vegetative experiments on Norfolk fine sandy loam and in nitrification experiments with the mixture of Norfolk and Gloucester soils. The data secured are given in Table 3.

(Continued on next page)

Table 3

Influence of Storage Conditions on the Availability of Insoluble Nitrogen from UAL-37

Storage temperature (2 weeks)	Dry weight grams	Nitrogen in crop mgms.	Nitrate nitrogen, parts per million of soil: 30 days	60 days	90 days
70°F.	12.8	170	32.3	41.1	44.5
90	13.7	194	31.1	59.0	50.8
110	13.2	146	32.8	67.8	64.5
130	13.7	175	38.4	67.4	57.2
160	12.0	140	32.3	56.1	42.8
Time of Storage at 110°F.					
3 days	12.7	159	43.7	64.5	79.5
7	15.5	216	36.5	72.8	63.5
14	13.2	146	32.8	67.8	64.5
28	12.7	173	40.8	47.2	50.5
56	13.5	181	51.2	72.1	60.5

Storage temperatures varying from 70° to 160°F. during a two-week storage period did not significantly influence the availability of the nitrogen as indicated by yield or nitrification data. The time of storage up to 56 days did not influence the availability of the insoluble nitrogen. Such data indicate the nitrogen compounds formed from UAL-37 are stable under most conditions of storage that would be encountered in the manufacture of fertilizers.

General Conclusions

The results of these vegetative and nitrification experiments indicate the insoluble nitrogen derived from UAL-37 is a good source of nitrogen for growing crops. It compares favorably with many insoluble nitrogen materials used in the manufacture of fertilizers. Both vegetative and nitrification experiments indicate, too, that the availability of the nitrogen does not change in storage.

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